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R. Hooijenga

Two old graphical constructions *F.J. de Vries* *12*

Two older geometrical sundial constructions were recently discussed.

The first, on the Genesio Church in Dairago, near Milan, and reverse-engineered by Cintio, appears in a paper by Gunella. Fer illustrates the principle for a Dutch wall on 52 degrees latitude, declining 30 degrees towards the east. Fig. 1 shows meridian and horizon, and a side view of a style triangle for a direct south dial on latitude Phi. Point C is the origin of the hour lines. Square to the style is the equator, which intersects the meridian in a point of the equinox.
From the intersection of meridian and horizon, there is a line making an angle equal to the declination, d. The horizontal dimension of the style triangle is circled onto this line, and from there a perpendicular g is dropped onto the horizon. This gives us the substyle, and the angle between substyle and meridian may now be measured.
The equinox goes through the point found earlier and square to the substyle. It intersects the horizon in a point of the VI line. Finally, g is circled onto a line square to the substyle. From the point so found, a line to C gives us the style triangle for this declining sundial, and its style elevation v.
Fig. 2 shows how the centre of an auxiliary circle is found. From its centre, hour lines like those for an equatorial dial are drawn every 15 degrees, starting at the XII line. They intersect the equinox. The figure also shows the hour angle of the substyle; it is needed later. In Fig. 3, the actual declining dial hour lines are drawn from C through the respective intersections on the equinox of the lines drawn in the previous figure.
In Dairago, the construction is different; see Fig. 4. Here, the auxiliary circle is moved to the meridian, and its XII line is drawn vertically. The equinox is rotated through an angle equal to the hour angle of the substyle, about the intersection with the substyle. Otherwise, the hour line construction proceeds similarly.
Why was this done? Perhaps in order to get the auxiliary circle in a more convenient spot. But there are more possibilities for its location: it may be translated squarely to any desired hour line, and the equinox rotation equals the angle between the construction line in the circle for that hour angle and the substyle.
The centres of all possible auxiliary circles lie on a circle.

The second construction is that by Zarbula. Fer repeats it for the same wall as in the first construction.
The substyle is found empirically from a date line, using the shadow of a temporary gnomon in the chosen point C on the meridian; Fig. 5. Zarbula did not need to know the declination of the wall. Fig. 6 shows how, using a direct south style triangle, the horizon and equator are drawn. The equinox is square to the substyle (because Zarbula worked in a latitude of very close to 45 degrees, he only needed a circle and would use its horizontal diameter as the horizon, thus dispensing with the style triangle construction).
We now have the hour points for VI and XII. We could draw a circle through them and find the centre of the auxiliary circle on the intersection with the substyle; Fig. 7.
However, Zarbula probably used a carpenter's square, which accomplishes the same thing, as is clearly visible in the last photograph.
For the construction of the style triangle on the substyle, a circle is drawn with the intersection of the substyle and the equinox as its center, through the centre of the auxiliary circle. The tangent from C on this circle gives us style and its elevation. Of course, this may also be constructed using the try square, see Fig. 8.
Note that the constructions in figures 2 and 8 are not the same: the right angle in the respective style triangles are in different locations. The style elevation is equal in both cases, of course. If, in Fig. 8, we draw a line from the intersection of substyle and horizon to the right angle, we get the style triangle from Fig. 2.

The Zarbula method is a quite practical one: with little preparation and few tools, a sundial may be constructed directly onto a wall. The Dairago method requires more preparatory constructions or calculations.

Bronze wall dial in Peize *F.W. Maes* *18*
For this dial, artist Jansink cast bronze directly between Ytong™ aerated concrete blocks. These popular building blocks are relatively easy to work with. They may be cut out for a spatial object, or separated using an iron strip for a flat sheet. The air in the cells makes for an enchanting surface effect.
The dial is almost south; it declines 9 degrees towards east, as Maes determined using Google Earth (the accuracy of about one degree seems appropriate for everyday dialling purposes). Hour points are on a strip; 9, 12 and 15 are accented. Note the maker's trademark, a red hat, over his initials at bottom right.

Cube dial by Harry Bult *F.J. de Vries* *19*
Harry made this dial for his son Michel's 40th birthday. Trespa® slabs are glued onto a core of wood. Numerals and lines, for local apparent time on all five dials, were engraved by hand. The gnomons are made of stainless steel, as is the black-coated base. On the base is a table for LAT to MET conversion. In summer, add an extra hour.
The motto means: Loss yields wit.

Leiden to get largest sundial *F.W. Maes* *20*
The idea here is to place a gnomon on the roof edge, and plot its shadow on the parking lot over the course of a year. Students should calculate the correct positions beforehand, and will see their theory checked by practice.
Whether or not this really constitutes the largest sundial is open to debate. The Mont St. Michel dial certainly is bigger.
The Leiden gnomon is a 2,5m diameter disk with a 0,8m diameter hole in it. It should be usable out to about 91m – not nearly enough in theory, but then the parking lot is not infinite. But a second cause of blurriness is the shadow's enormous elongation at the lower altitudes of the sun. A smaller scale setup shows what should be expected (photos). – The Leiden Astronomy web site shows an hour line pattern that does not seem correct. Fig. 6 shows a better pattern.

Sundial from the Vindonissa colony *'20 Minutes' (Switzerland)* *23*
At excavations near Windisch, in the northwest of Switzerland, a student found a white stone in the base of a small wall. This fragment shows lines typical for a Roman spherical sundial. Given that this was the site of a Roman legion camp, the conclusion would be that the fragment is of a Roman sundial from that period.

Treble nodus dial by Mac Oglesby *F.J. de Vries* *24*
Nodus dials are capably of keeping time in many different systems. The resulting combination patters can be confusing, however. Here is a treble node sundial that has separate dial faces for each of the three systems: hours since sunrise, hours until sunset, and a modern variant on the Antique hours: percentage of total daylight remaining.

Sidereal time on Homogenous Analemmatic Sundial *H.J. Hollander* *25*
Sidereal time is really the hour angle of vernal equinoctial point, much like solar time is the hour angle of the sun. The figures explain: at the start of spring, the sun is in the vernal point, and 0:00 sidereal and 12:00 solar time coincide. A month later, when the vernal point culminates, the sun is still east of the meridian. The angle alpha is called the right ascension. Somewhat later, the sun souths, and the vernal point has moved towards west through the angle alpha.
Because the difference between local apparent time and local sidereal time is equal to the right ascension of the sun (plus a constant twelve hours), it is possible to read sidereal time on the movable part of the on the homogenous analemmatic sundial: right ascension is plotted along the months, starting at 20 March; see Fig. 5.
In the figure, LAT is read at the arrow near 23 September, as usual. The shadow caster is on the vernal point, near 20 March. The figure shows the shadow for 20 April, 0:00 sidereal time, which is somewhat over 10 hours solar time.
In the situation of Fig. 2, the shadow would read 0:00 LST on 20 March, while the arrow would indicate 12:00 LAT. – This principle holds for any homogenous sundial. But in the

case of the homogenous analemmatic sundial, which is always adjusted to the suns position anyway, it does not take any additional action to read LST.

Equation of Time and Declination of the Sun *J.P.C. Hoogenraad* *28*
The equation of time at 12:00 MET each day is calculated using a geocentric model. First, the EOT is calculated as a function of the orbital angle of the sun in its annual revolution about the earth, taking into account the orbital angle at the passage of the vernal equinox. Next, iterating for discrete values of time, the relation between time and orbital angle is determined; then, the expression for EOT found earlier is converted into an equation relating, on a given date and time, the EOT and the amount of time since 1 January 12:00 of a given year, expressing date and time as a fraction of the year.
It is necessary for good results to have at one's disposal accurate external information, such as dates and times of perihelion and vernal equinox. Because the results were not entirely satisfying, – there was a mean difference of about 10 seconds with existing tables – an improvement was sought. When the author realized that not the earth, but the earth-moon system describes an elliptical orbit around the sun, he was able to use adjusted perihelion dates and times. This reduced the error considerably: on 51.5% of the days in six years, the difference with existing tables was 0 seconds. On 46% of the days, it was 1 second; on 2.5%, it was 2 seconds, which was also the maximum. One cause of these residual errors is the influence of other planets.
For the declination of the sun, a fairly simple expression is derived. The results are equal, to within one hundredth of a degree, to existing tables.

Symposium Carpe Diem, Mallorca *'Carpe Diem'* *41*
Announcement of the second meeting, from 7 to 10 May.

Wall declination from gnomon shadow *J.P.C. Hoogenraad* *42*
This appendix to the larger paper by Hoogenraad describes a method to obtain the declination of a wall (that is, the angle between its normal and south) from observations of the horizontal component of a gnomon shadow on that wall. An Excel spreadsheet is available from the author.

The Sailing Wooden Shoe by Jan Kragten *F.J. de Vries* *44*
Jan Kragten designed his Universal Capuchin card dial in 1992. The dial resembles a children's sailboat made out of a clog, and so this card dial is known as the Sailing Wooden Shoe.
Apparently, this was not the first universal Capuchin card dial ever made. Nicola Severino of Italy found two earlier examples in old literature.
One is from a book by George Hartmann, 1535. It shows the same pattern, although mirrored. The other, also mirrored, is from a book by Andrea Schöner, 1562.

Astro Clock part 1, supplement *B.P.U. Holman* *45*
The "Astro Clock" paper mentions Babylonian hours. There is, however, more than one time system known under that name. In dialling, we usually use 'Babylonian' to refer to a system of 24 equal hours, starting at sunrise.
Where astronomical timepieces are concerned, the same word refers to a system where sunrise is 0, noon is 6 and sunset is 12, making each daylight period equal to twelve hours. The dark period of the day likewise counts twelve hours, so that midnight is 18. It should be realized that in the Middle East, where this nomenclature originated, the difference in duration between day and night is less than it is in our provinces.

Unknown "Utrecht" proves "The Hague" *H.J. Hollander* *56*
The photograph of this dial was marked "Utrecht" on the back. Not fooled by this, De Vries found a reference in an old Bulletin. The photo turned out to be of The Hague-13.

Jahrestagung 2009, Arbeitskreis Sonnenuhren *Rick/Grenzhäuser* *60*
Invitation to the annual meeting 2009, from 21 to 24 May.